Naval Science & Technology Tutorial

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Military Deputy to the Technical Director,
Office of Naval Research

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National Defense Industrial Association

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http://www.onr.navy.mil

Outline

- Mission
- Investment
- Portfolio
- Recently delivered
- On the horizon
- Summary

Naval Research delivers...

Thermobarics

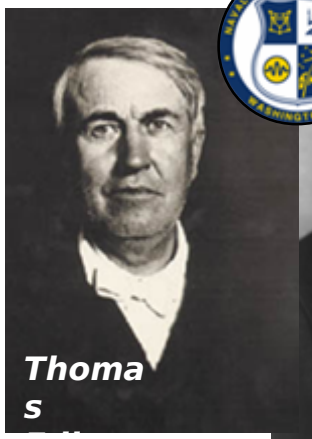
Affordable Weapon

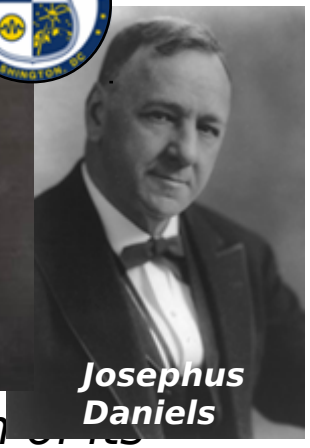
REMUS

...for Sailors and Marines

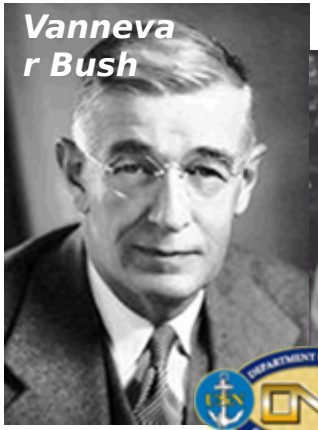
Naval Research: An Enduring and Evolving Mission

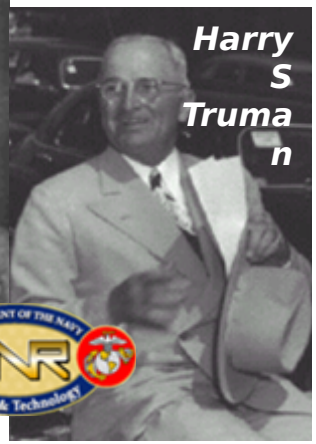
Naval Research Laboratory *(Appropriations Act, 1916)*: *"[Conduct] exploratory and research work … necessary… for the benefit of Government service, including the construction, equipment, and operation of a laboratory…."*





Office of Naval Research *(Public Law 588, 1946)*:
"… plan, foster, and encourage scientific research in recognition of its paramount importance as related to the maintenance of future naval power, and the preservation of national security…. "





Transitioning S&T *(Defense Authorization Act, 2001)*:
"…manage the Navy's basic, applied, and advanced research to foster transition from science and technology to higher levels of research, development, test, and evaluation."

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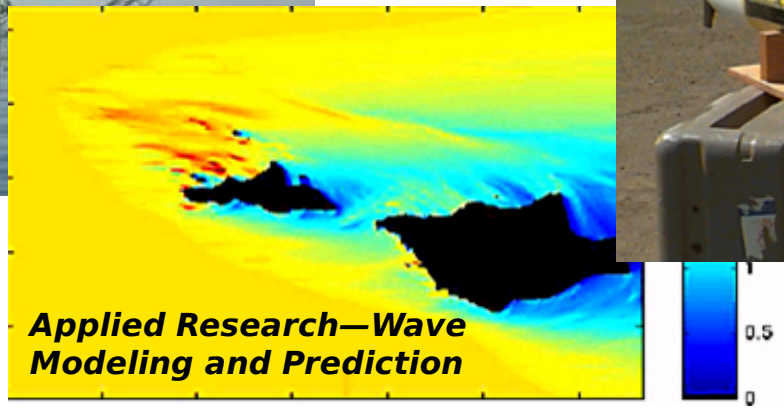
Integrated, Use-Inspired Research

- Basic Research (6.1)
- Applied Research (6.2)
- Advanced Technology Development (6.3)
- Development (6.4-6.6)

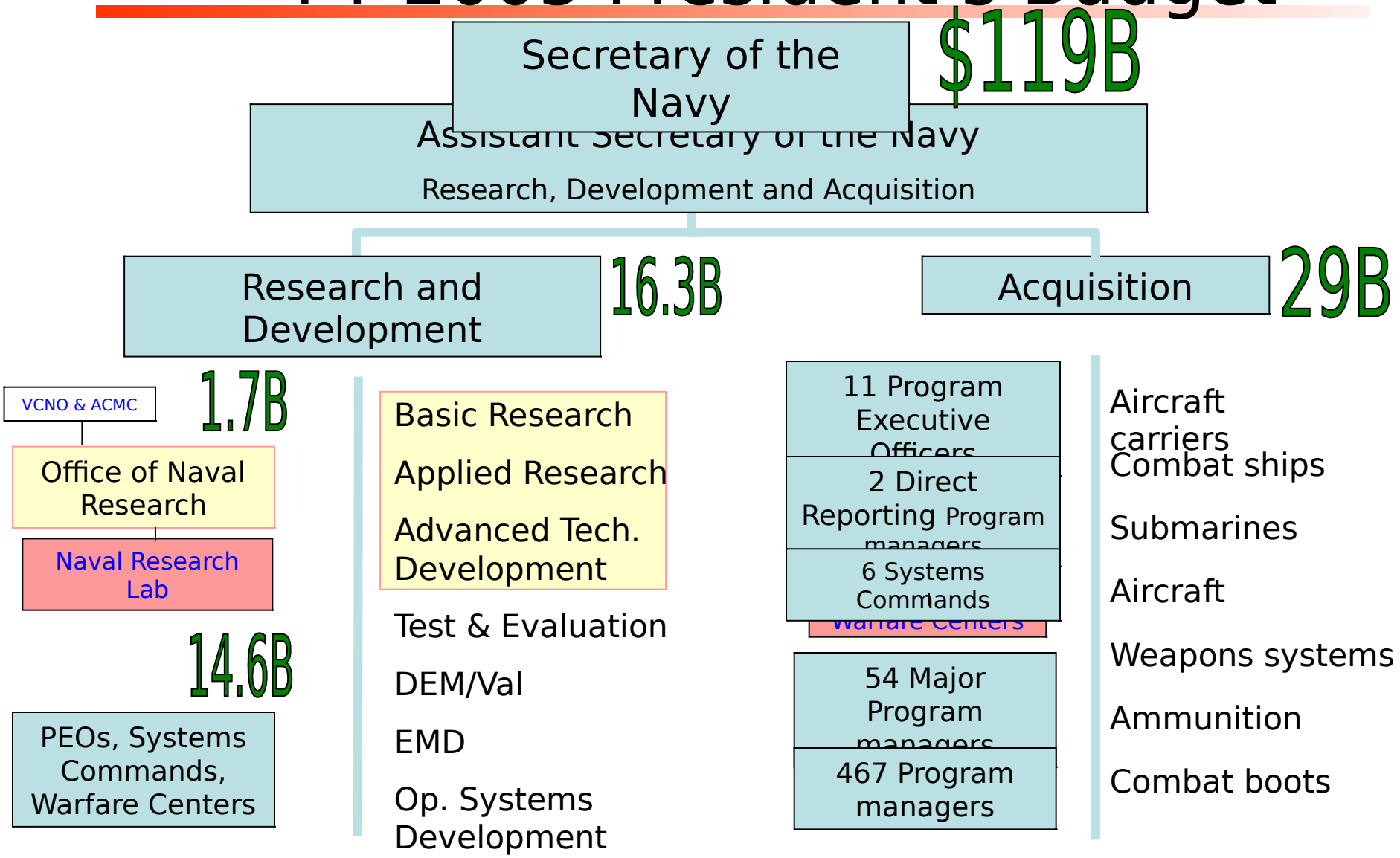
Science & Technology

Research, Development, Test, & Evaluation



Peer review of portfolios, not proposals

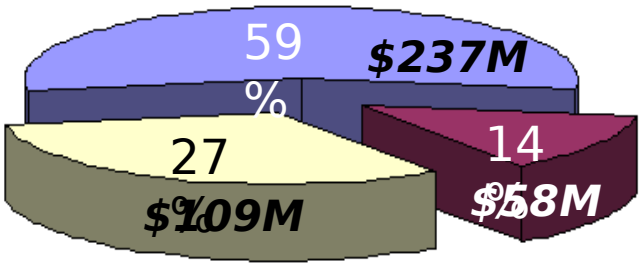
Naval S&T in Context: FY 2005 President's Budget



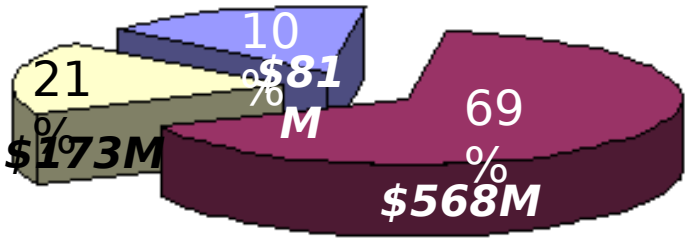
Source: FY05 Blue Book, FY05 R-1

Naval S&T Investment by Performer

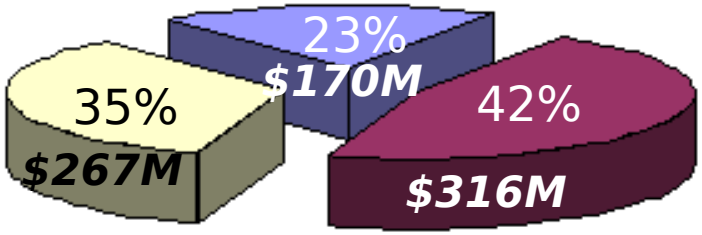
6.1

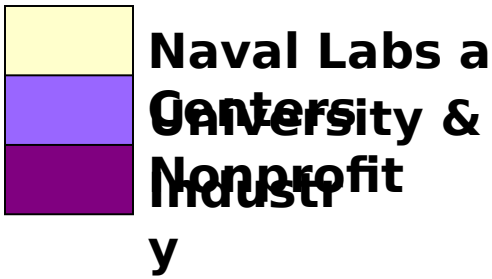


6.3



6.2





	BA 1	BA 2	BA 3
College/University	237	170	81
Industry	58	316	562
Navy	109	267	173

FY03 $M as reported in the FY04 National Science Foundation Survey of Federal Funds for RDT&E

S&T Investment Categories

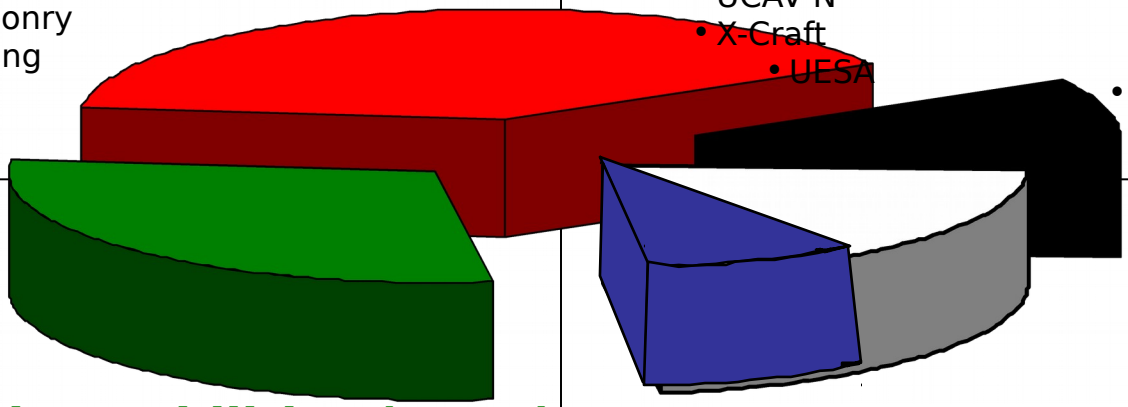
POM 06

Discovery & Invention (D&I)

- NRL Base Program
- Science shortfalls in topics with Naval interest
- Nurturing science opportunity
- High impacts/surprises
- Health of Academic pipeline – ideas/workforce
- National Naval Responsibilities
  - Ocean Acoustics
  - Undersea Weaponry
  - Naval Engineering

Innovative Naval Prototypes (INPs)

- Affordable Weapon
- Half-Length Torpedo
- Electromagnetic Gun
- Hy Fly-Hypersonic Strike
- Free Electron Lasers
- UCAV-N
- X-Craft
- UESA
- Virtual Technologies & Environments
- Persistent Littoral Undersea surveillance
- SEA Basing Enablers
- Tactical Use of Space
- 36 MW Superconducting Motor
- Advanced Multifunction RF System



Future Naval Capabilities (FNCs)

- Time Critical Strike (TCS)
- Organic Mine Countermeasures (OMCM)
- Knowledge Superiority & Assurance (KSA)
- Littoral Antisubmarine Warfare (LASW)
- Expeditionary Logistics (ExLog)
- Fleet/Force Protection (FFP)
- Littoral Combat and Power Projection (LCCP)
- Missile Defense (MD)
- Advanced Capability Electric systems (ACES)
- Autonomous Ops (AO)
- Total Ownership Cost Reduction (TOC)
- *Capable Manpower (CM)*
- *Warfighter Protection (WP)*

Quick Reaction and Other

Quick Reaction

- SwampWorks
- Tech Solutions
- MCWL

Other

- Pass-Through - to JFCOM
- OSD Directed
- Infrastructure - Efforts enabling ONR's mission execution such as IFO, conferences, outreach

S&T Funding

FY 04 (PB, $M)

Three S&T Portfolio Categories

1. Discovery and Invention (D&I) *6.1 & early 6.2* **668.5**
2. Future Naval Capabilities (FNC) *late 6.2 & 6.3 6.2* **500.0**
3. Other Exploitation & Deployment (E&D) *late 6.2 & 6.3 6.2* . **344.5**

Other S&T

Pass-through and other . . . . . .

- JFCOM, Naval Warfighting Experiments, etc **201.3**

Total President's Budget S&T

Congressional Actions **1,714.3**

528.0

Total DoN S&T Funding

2,242.3

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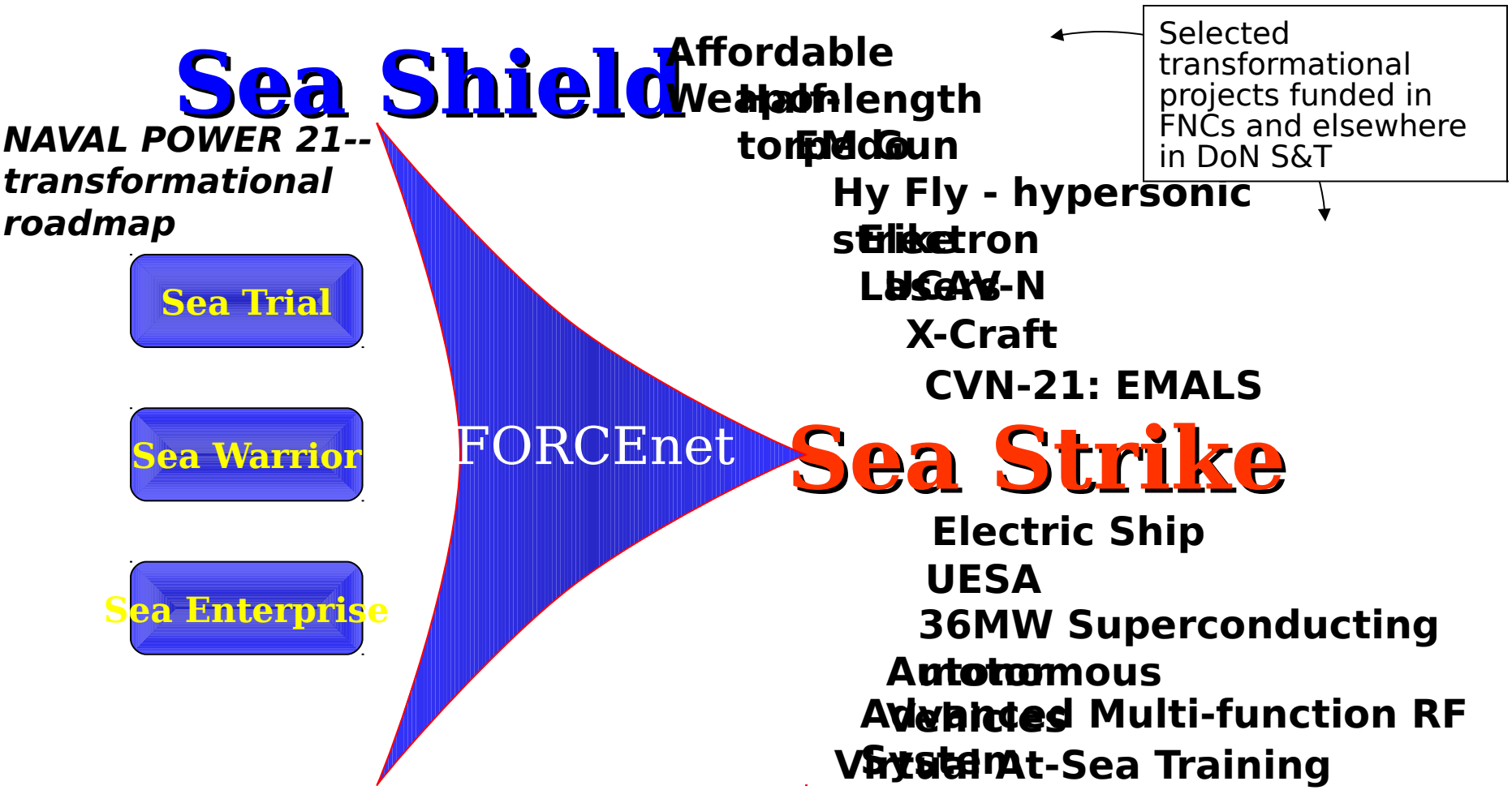
S&T for Naval Transformation



Framework for Naval S&T Strategy

- Positioning in market
  - *Naval Unique*
  - *Naval Interest*
  - *Naval Harvest*
- Value proposition: $\frac{\text{\$ value of output product} \times \text{probability of success}}{\text{\$ invested}}$
- Reduced time-to-market
- Motivation for investment
  - *Transformational concept of operation*
  - *Technology opportunity*
  - *Capability gap*

Valuing Naval S&T

- FNCs
  - –Transitionable products
    - Quantifiable by value of products
- Innovative Naval Prototypes
  - –Transformational options
    - Quantifiable by value of products

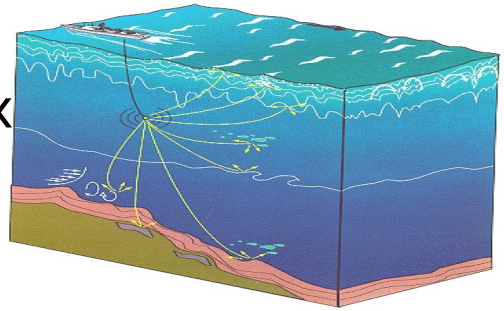
Discovery & Invention

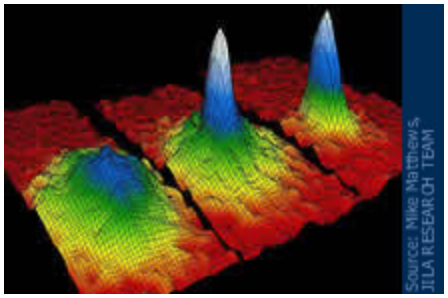
- –Future capabilities & options
- –Lower cost of present capability

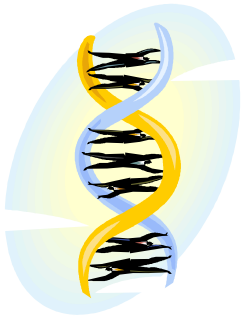
National Naval Responsibilities

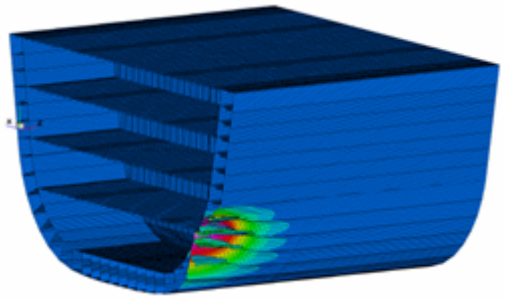
What we do all the time:

- Naval environment is distinctive and complex
- Naval science and technology must maintain areas critical to ensuring Naval superiority:
  - –Robust U.S. research community
  - –Adequate pipeline of new scientists and engineers in Naval-unique disciplines
  - –Ensured future S&T products to Naval forces
- National Naval Responsibilities:
  - –*Ocean Acoustics*
  - –*Underwater Weaponry*
  - –*Naval Engineering*
  - –*Undersea Medicine* *(consideration)*









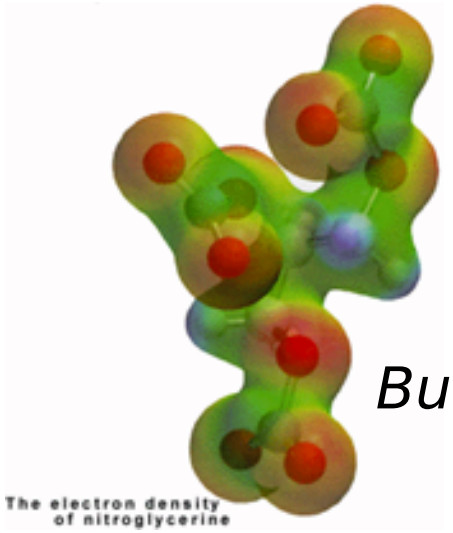
Discovery & Invention – Grand Challenges

The Grand Challenges are:

- Visionary—for the Navy & Marine Corps after Next
- Compelling—answering a Naval need
- Long-term—completed over 20 to 50 years
- Very difficult, but probably achievable
- Multi-disciplinary with multiple participants and multiple opportunities

But not

- *Mere* linear extensions of present programs
- Massive engineering projects


The electron density of nitroglycerine

Four Grand Challenges ***(established 1998; vetted by Jasons and NSB)***:

- ***Naval Battlespace Awareness***
- ***Electrical Power Sources for Naval Forces***
- ***Naval Materials by Design***
- ***Multifunctional Electronics for Intelligent Naval Sensors***

 Images courtesy Nobel e-Museum

Future Naval Capabilities (FNCs)

What we do for tomorrow:

- Advanced Capability Electric Systems
- Autonomous Operations
- Capable Manpower
- Fleet / Force Protection
- Knowledge Superiority & Assurance
- Littoral Antisubmarine Warfare
- Littoral Combat & Power Projection
- Expeditionary Logistics
- Missile Defense
- Organic Mine Countermeasures
- Time Critical Strike
- Total Ownership Cost Reduction
- Warfighter Protection

Autonomous Operations

Warfighter Protection

Missile Defense

Investment: ~$500M per year

Innovative Naval Prototypes
(under consideration)

- X-Craft
- Hi-Fly
- Sea Flyer
- Silver Fox
- Affordable Weapon System
- UCAV-N / X-47A
- Half-length Torpedo
- High Temperature Superconducting Motor
- Free Electron Laser
- Rail Gun
- Littoral Netted ASW
- Sea Base Enablers
- Space—MicroSat / TacSat

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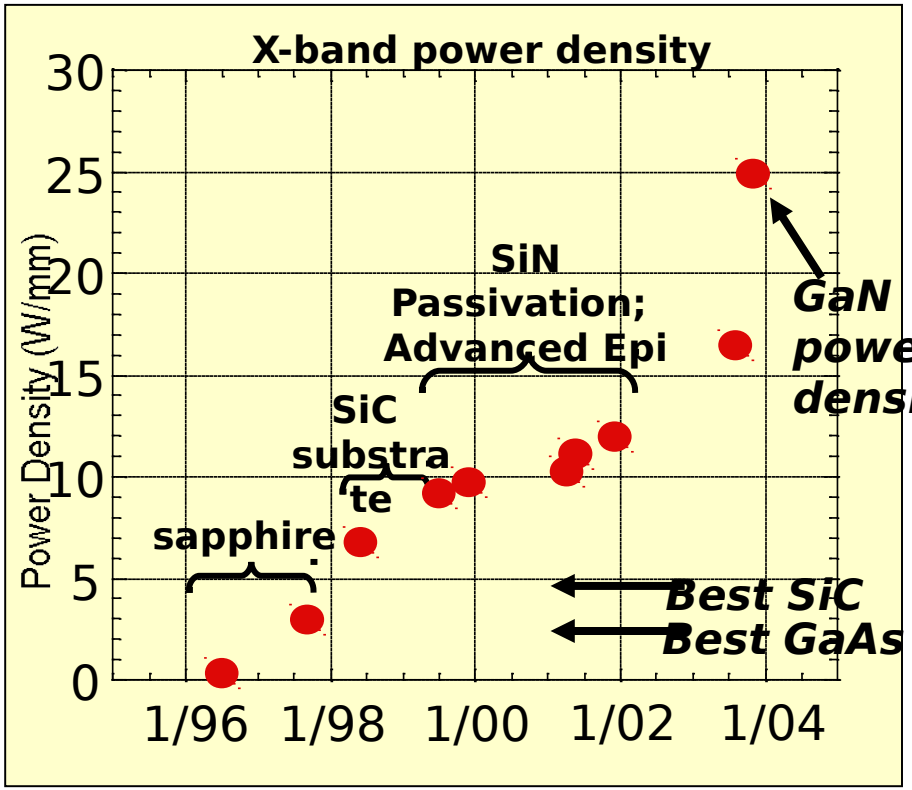
Basic Research Payoff – Wide Bandgap Semiconductor Materials



- ***Microwave receivers***
- ***Military aircraft radars***
- ***Military RF detectors***
- ***Cell phones***
- ***Multicolored displays***
- ***Power switching devices***
- ***…***

Creating an industry through universities and small businesses…

Specific Emitter Identification

RF fingerprints

SEI extracts subtle but persistent features of a radar signal to create a fingerprint unique to a specific radar.

From container ships…

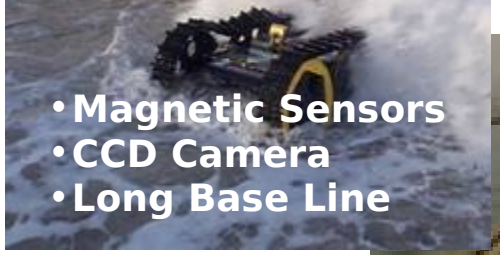
…to dhows

AN/UYX-4 SEI equipped USS Benfold patrols Arabian Gulf

Vessel identification and tracking becomes a science, no longer an

Vehicles:
Robots do the dangerous work

Tactically Adaptable Crawlers



- Magnetic Sensors
- CCD Camera
- Long Base Line

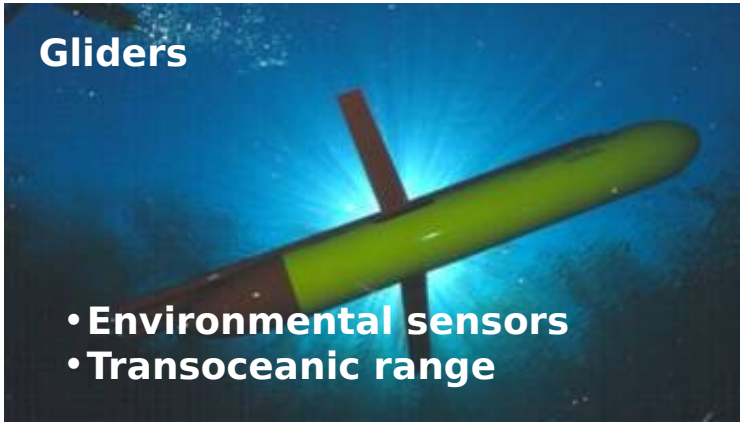
REMUS at war—Um Qasr, Feb 03

Battlespace Preparation AUV

- Recon/minehunting
- Long endurance (17hrs
  -Klein 5400 Sidescan Sonar
  - GPS/INS -
  CAD/CAC

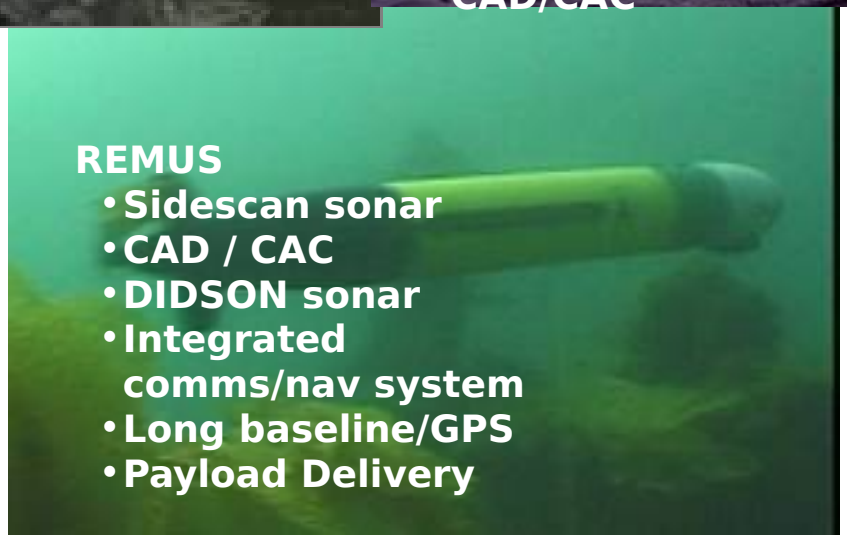
Deployable, affordable, adaptable systems find mines

Gliders



- Environmental sensors
- Transoceanic range

REMUS



- Sidescan sonar
- CAD / CAC
- DIDSON sonar
- Integrated comms/nav system
- Long baseline/GPS
- Payload Delivery

Thermobarics
Delivered in < 6 months

30 years of basic chemistry yields combat options

Virtual At Sea Training (VAST)

(instead of Vieques)

<u>Realistic</u> fire support training no longer needs a range

Digital Precision Strike Suite
Strike for special operations

Digital Precision Strike Suite (DPSS) links strike aircraft and special operators

Digital Precision Strike Suite made F-14s strike aircraft of choice over Afghanistan &

Titanium Fabrication Processes for Expeditionary Howitzer

Reduces M777 155mm howitzer weight by 45%

M777 spade production began October 2003.

M777 saddle and cradle tubes will enter production October 2004.

Saves $45M over 650 unit

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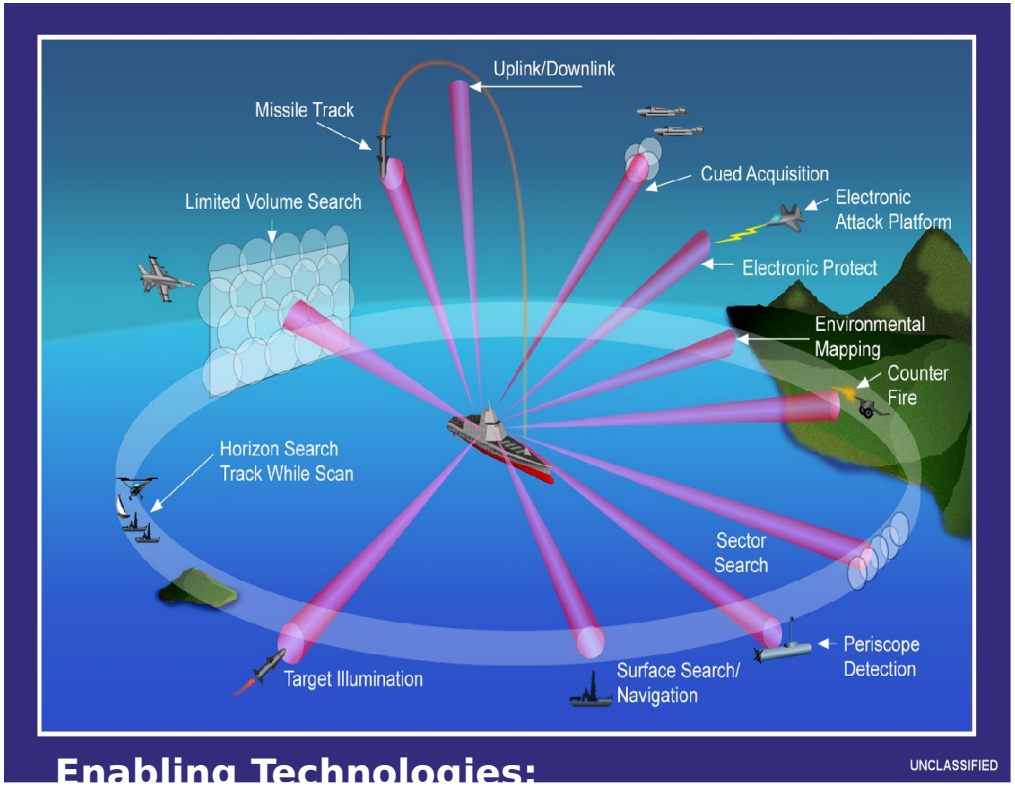
What's coming

- Investments with potentially significant cost reductions
  - Materials and processes
  - Training and manning
- Persistent surveillance technologies
- Autonomous systems
- Hypersonic strike: EM gun and hypersonic cruise missile
- New surface ship technologies: materials, propulsion, surveillance systems

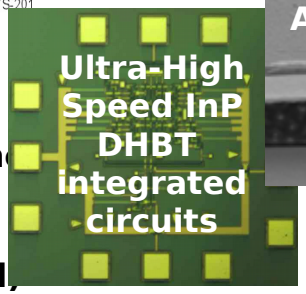
Advanced Multi-Function RF

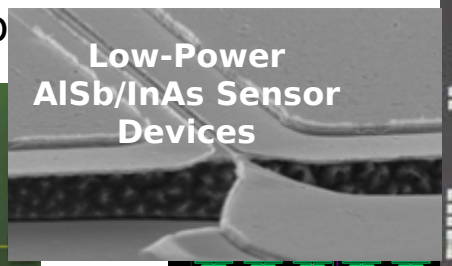


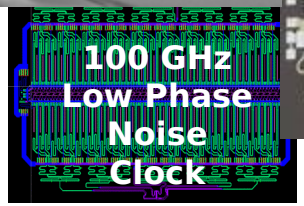
Next Generation Radar Requirements:

- High dynamic range
- Wide instantaneous bandwidth
- High sensitivity
- Multi-functionality
- Multi-beam capability
- Search, track, and discriminate capability
- Clutter rejection
- Low sidelobes
- Adaptive nulling
- Illumination
- Detectio

- **High Power Solid State Amplifiers**
  - Improved efficiencies and multi-octave bandwidths.
  - Achieved factor of 5 increase in power levels over GaAs
  - Projected replacement of all Vacuum Electronics in fleet
- **Direct Digital Beamforming at Microwave Frequen**
  - Demonstrated word record DDS at 4.6 GHz RF
  - Projected DDS to 20 GHz frequency
  - Multiple simultaneous beam capacity
- **80+ GHz Flip-Flops achieved @ (120GHz projected)**
- **100 GHz sources with 120dBc @ 1Khz (projected)**
- **5GHz Center Frequency, up to 500 MHz programmable bandwidth ADC's (projected)**
- **New Software Definable RF Apertures and Architectures**



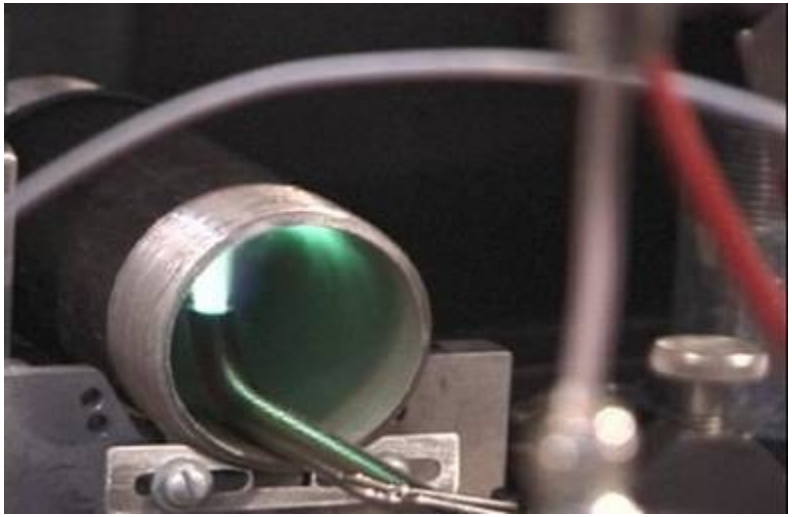




Zero Maintenance Materials

Nanostructured coatings with unprecedented damage tolerance & bond strength—now entering service

Nanotechnology is here…today



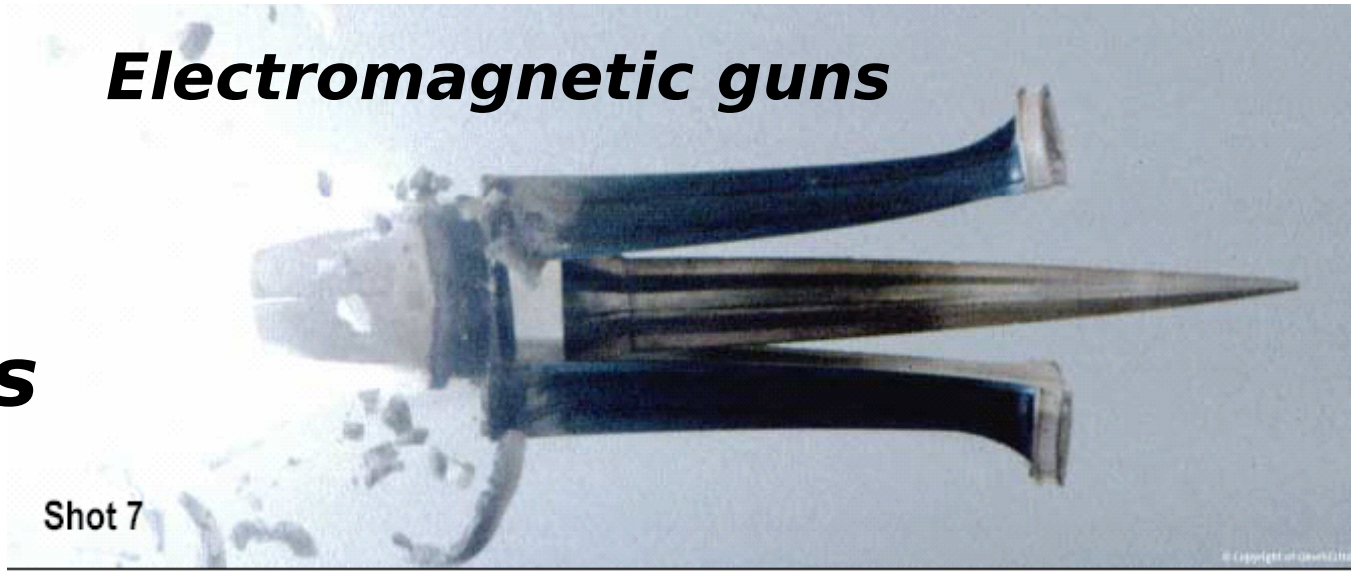
A totally new coating process based on miniature pulsed rocket motors and capable of coating restricted surfaces—coming soon

Advanced Corrosion Control

Better coatings for ships' tanks

Hypersonic Strike

Speed kills



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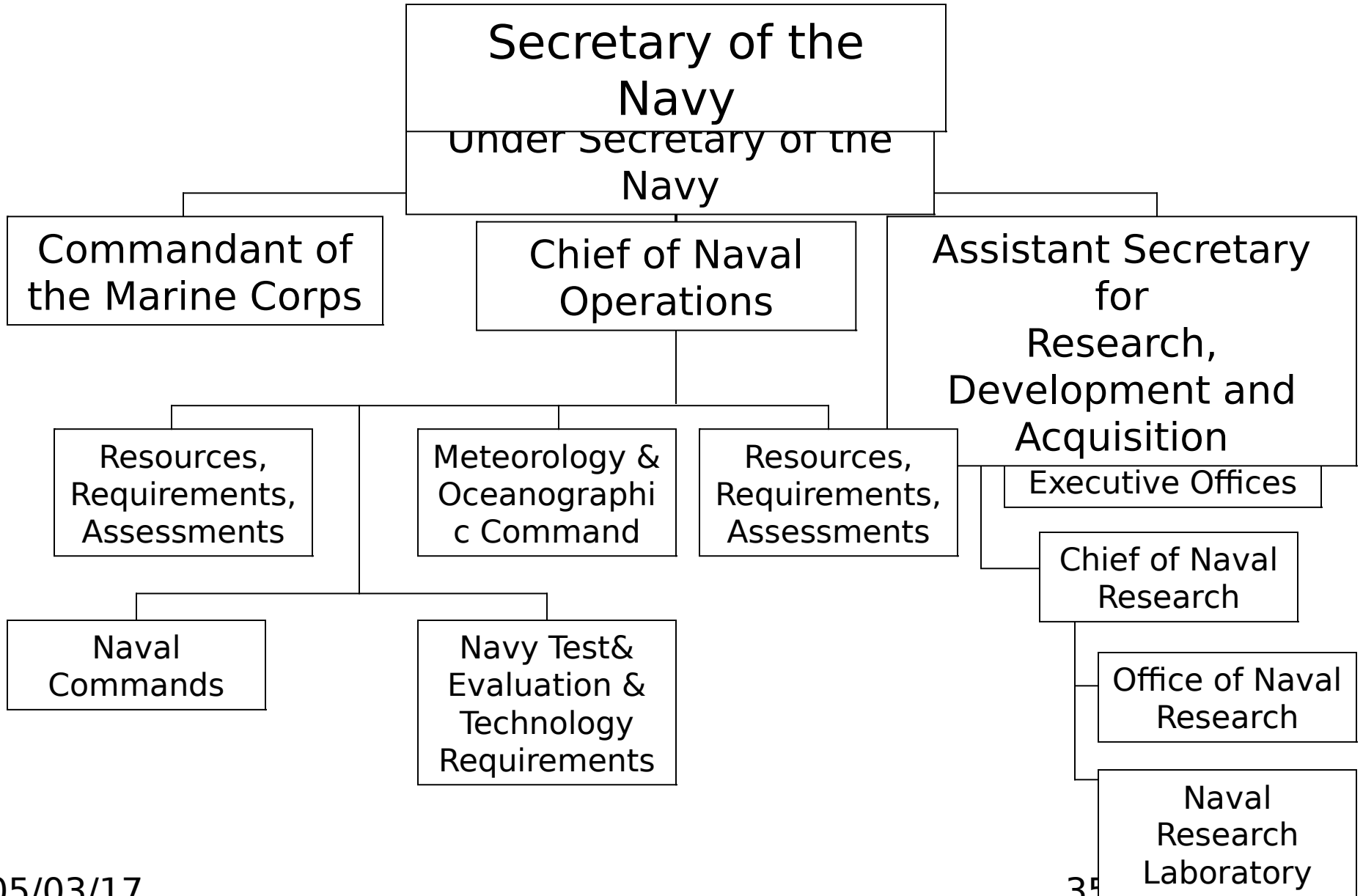
Naval Science & Technology Vision

To inspire and guide innovation that will provide technology-based options for future Navy and Marine Corps capabilities…

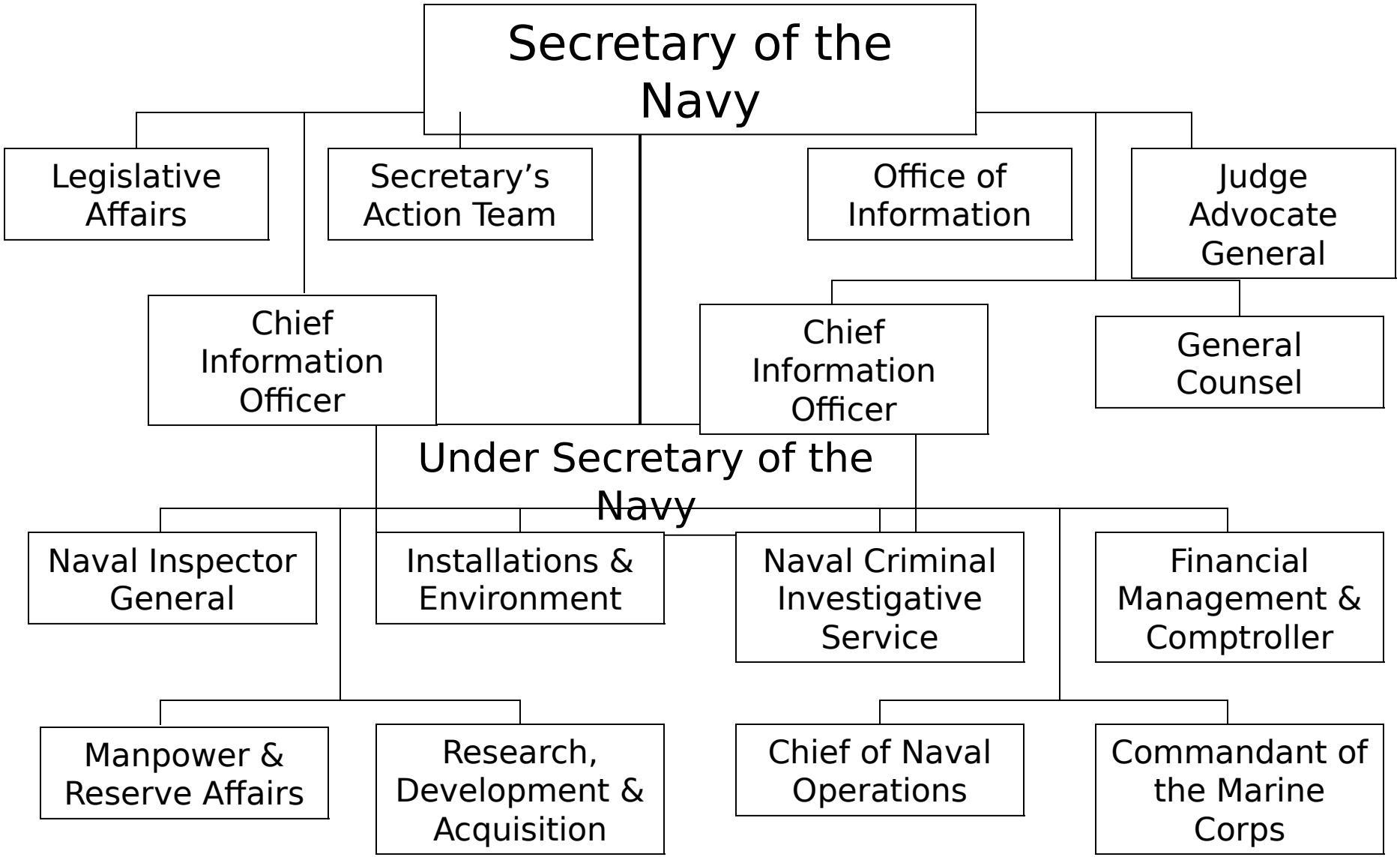
SEALs in Operation Iraqi Freedom

…and to avoid technological surprise.

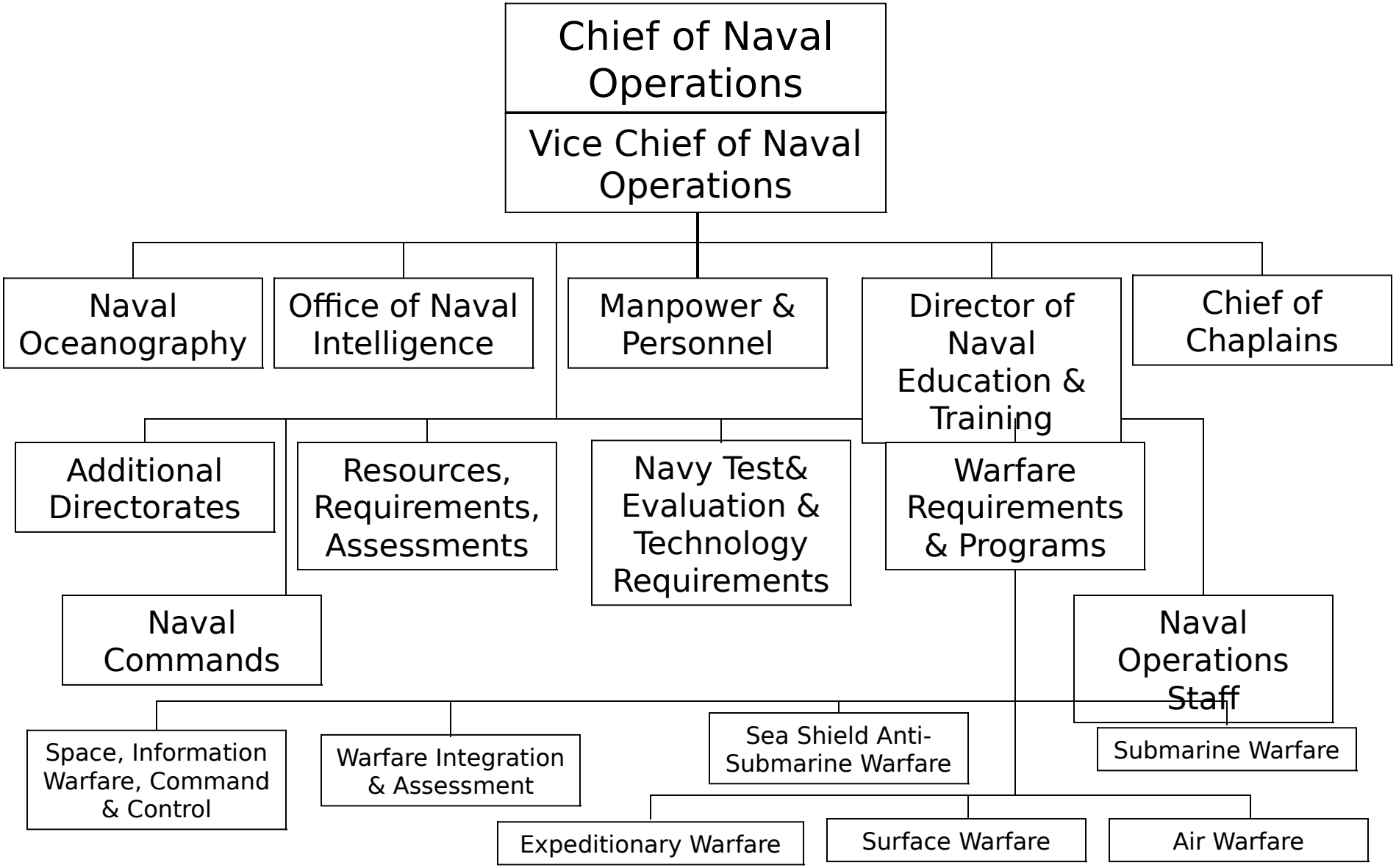
Department of the Navy


Secretary of the Navy
Under Secretary of the Navy
Commandant of the Marine Corps
Chief of Naval Operations
Assistant Secretary for Research, Development and Acquisition
Resources, Requirements, Assessments
Meteorology & Oceanographic Command
Resources, Requirements, Assessments
Executive Offices
Chief of Naval Research
Naval Commands
Navy Test& Evaluation & Technology Requirements
Office of Naval Research
Naval Research Laboratory

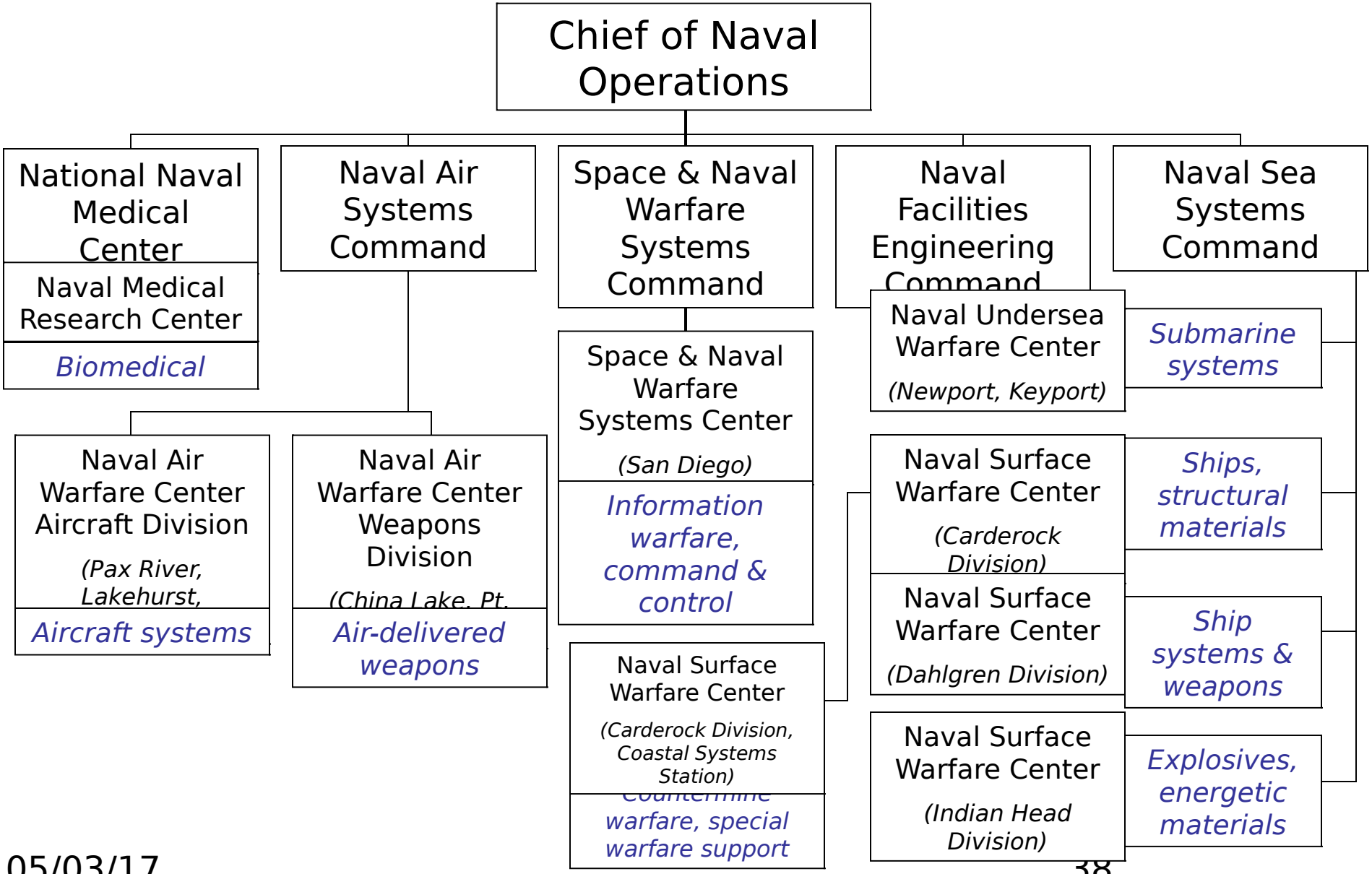
Secretary of the Navy



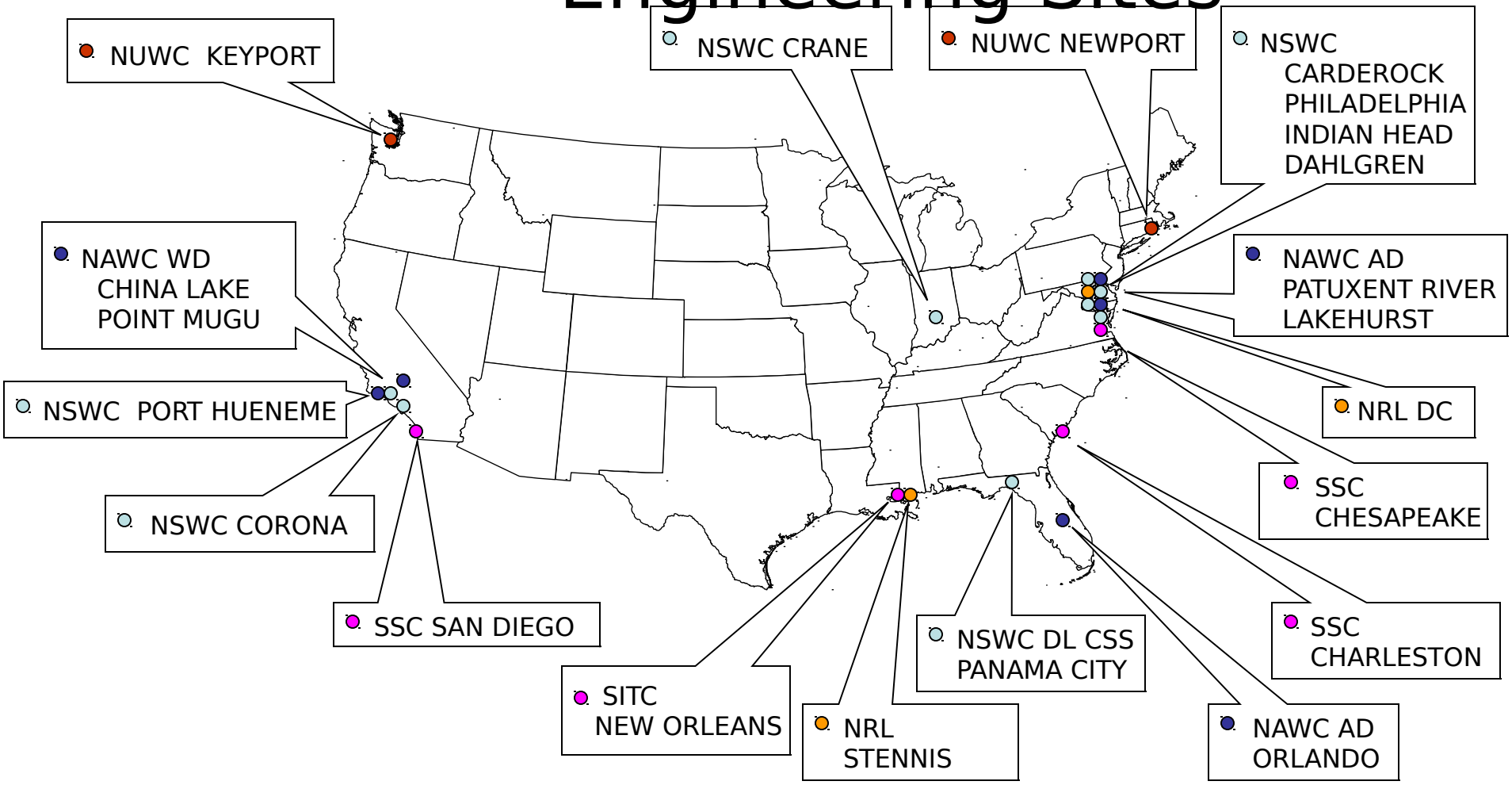
Chief of Naval Operations



Naval Warfare Centers

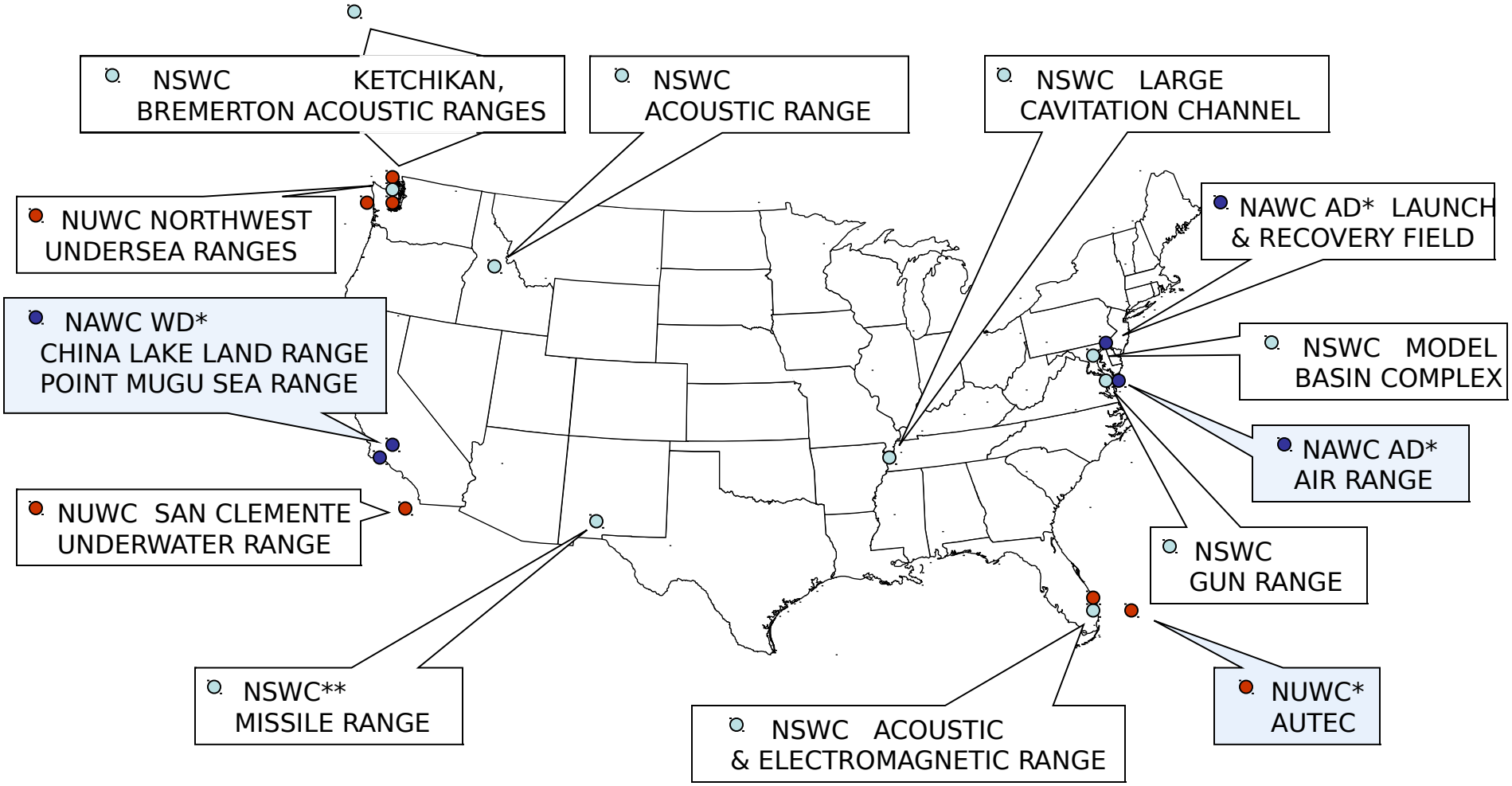


Major Research & Development & In-Service Engineering Sites



SITC = SPAWAR INFORMATION TECHNOLOGY CENTER
DL CSS = DAHLGREN DIVISION COASTAL SYSTEM STATION

Major Test & Evaluation Sites


NSWC KETCHIKAN, BREMERTON ACOUSTIC RANGES
NSWC ACOUSTIC RANGE
NSWC LARGE CAVITATION CHANNEL
NUWC NORTHWEST UNDERSEA RANGES
NAWC AD* LAUNCH & RECOVERY FIELD
NAWC WD* CHINA LAKE LAND RANGE POINT MUGU SEA RANGE
NSWC MODEL BASIN COMPLEX
NAWC AD* AIR RANGE
NUWC SAN CLEMENTE UNDERWATER RANGE
NSWC GUN RANGE
NSWC** MISSILE RANGE
NUWC* AUTEC
NSWC ACOUSTIC & ELECTROMAGNETIC RANGE

*DOD MAJOR RANGE AND TEST FACILITY BASE (MRTFB) AFFILIATE

AUTEC: ATLANTIC UNDERSEA TEST AND EVALUATION CENTER
NUWC NW RANGES INCLUDE NANOOSE, DABOB BAY AND QUINALT SITES
**NSWC MISSILE RANGE/"DESERT SHIP" IS A TENANT AT THE ARMY'S WHITE SANDS MRTFB SITE

The Naval Research Enterprise

- NAVSEA
  - NSWC DAHLGREN
  - NSWC CARDEROCK
  - NSWC CSS PANAMA CITY
  - NSWC INDIAN HEAD
  - NSWC NEWPORT /KEYPORT
  - NSWC PORT HUENEME
  - NSWC CRANE
- SPAWAR
  - SSC-SD
  - SSC-CH
- NAVAIR
  - NAWC-WD
  - NAWC-TSD
  - NAWC-AD
- MARCOR SYSCOM
- MCWL
- NAVOCEANO
- NFESC
- BUMED

CNR coordinates a consortium of S&T elements in Systems Commands, Warfare Centers, Naval Laboratories, UARCs, FFRDCs, other naval

- APL JHU
- ARL PSU
- ARL UT
- APL UW
- NWC
- CNA
- NPS
- NRL
- NWDC
- SIO
- WHOI
- Electric Ship R&D Consortium (FSU, USC, MSU, UTA, USNA, NPS, MIT, Purdue, NMT, UMR, UNO, UWis)
- U Hawaii (Proposed)
- Stevens Institute Center for Maritime Studies (Proposed)